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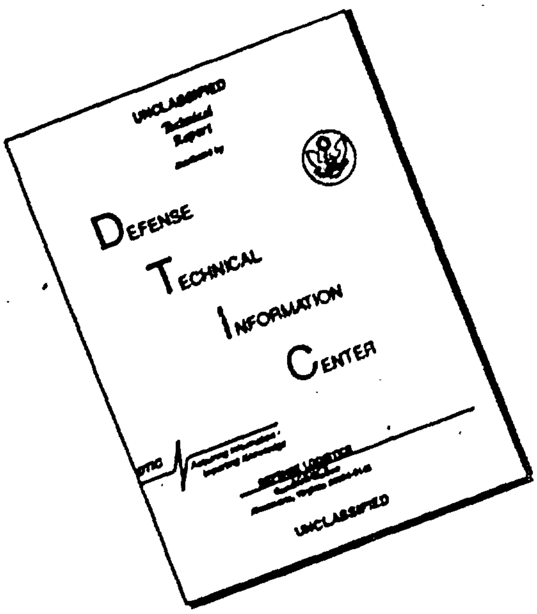

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AIR TECHNICAL INTELLIGENCE TRANSLATION

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CONSTRUCTION AND OPERATION OF
THE M-11FR ENGINE

by

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THE R-2 RPM REGULATOR AND THE PROPELLER
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The rpm regulator. Designation of the rpm regulator.

The R-2 rpm regulator is intended for automatic control of the variable pitch propeller.

Construction of the rpm regulator

The R-2 rpm regulator (Fig. 125) consists of three aluminum alloy cast bodies: the lower 1, center 2 and upper 3.

The lower body 1 serves for installing the regulator on the engine and connection of same with the drive and the lubrication system of the engine.

In the center body 2 of the oil pump, a gear oil pump with reduction valve is installed. The oil pump feeds the oil under high pressure into the propeller mechanism and brings the propeller into action.

The bodies 1 and 2 are provided with channels for the delivery and drainage of the oil to and from the oil pump of the regulator.

The channel in body 1, through which oil is delivered to the regulator pump, has two inlets marked with letters A and B (not marked on drawings) engraved on the body above these inlets.

One of these channels is plugged up with a stopper depending upon the direction of rotation of the regulator. On the M-11FR engine, the plug in the lower body of the regulator is inserted into the opening marked with letter B.

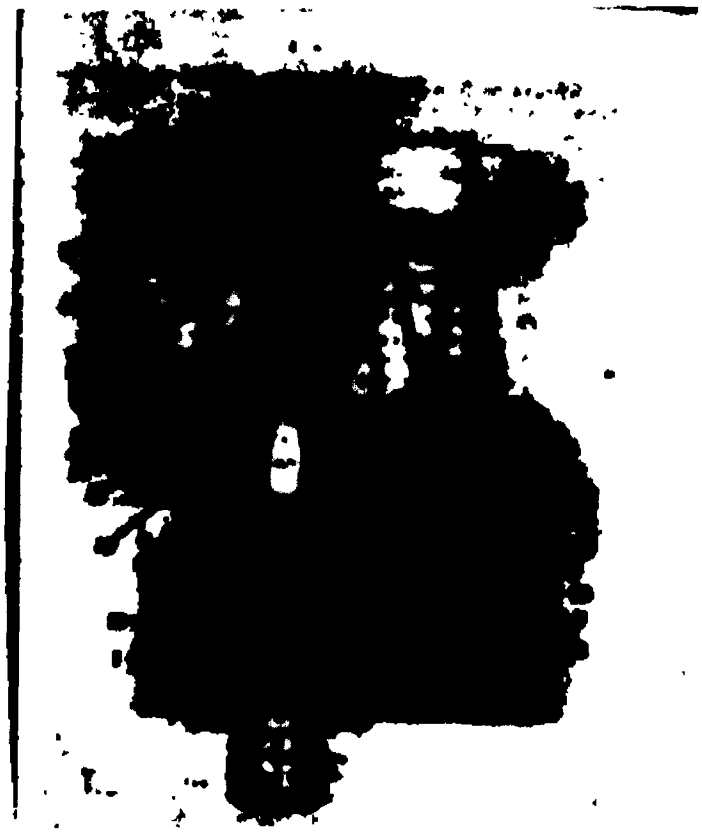

Figure 125. The R-2 rpm regulator (sectional view)

1 - lower body; 2 - body of oil pump; 3 - body of regulator; 4 - small manual control shaft; 5 - rack; 6 - roller; 7 - master shaft (driving shaft); 8 - weights of regulator; 9 - slide valve; 10 - driven gear; 11 - gear axis; 12 - gasket; 13 - bell; 14 - weight axis; 15 - spindle; 16 - bearing; 17 - slide valve spring; 18 - lock nut; 19 - packing spring; 20 - ring; 21 - gasket; 22 - bearing housing; 23 - pin; 24 - gasket; 25 - washer; 26 - lock washer; 27 - lock nut (positions 19, 20, 21, 22, 23, 24, 25, 26, 27 see Figure 126); 28 - spring; 29 - reduction valve; 30 - valve guide; 31 - loc nut; 32 - packing ring; 33 - bracket; 34 - plate.

The upper part of body 2 of the oil pump, together with body 3 of the rpm regulator, form a chamber which houses a centrifugal regulator.

In the upper part of the governor body is placed the manual control mechanism, consisting of small shaft 4 combined into one with the gear which is meshed with (engages) the toothed rack 5, control roller 6 and packing.

The driving shaft 7, combined into one unit with the driven gear of the oil pump, rotates within the bodies 1 and 2. The lower end of the driving shaft is coupled through slits with the transmission shaft, and the upper end is inserted in the bottom of the weight bracket 33.

The interior of shaft 7 is provided with windows (ports) for the passing of the oil and an axial (longitudinal) precision machined orifice in which the slide valve 9 moves with very little clearance.

The driven gear 10 of the oil pump rotates on a cast iron axle 11 pressed into body 1. The axle has port holes for the flow of lubricating compounds toward the friction surface of the gear and axle.

The bodies of the transmission and oil pump are interconnected (joined) by means of conical bolts; such a jointing protects the bodies against mutual displacement and consequently also against possible jamming of the driving shaft. Packing gasket 12 serves as packing between the two bodies.

The weight bracket 33 has two sets of lugs in the opening of which the axles 14 are inserted. On the axles 14 are mounted two weights 8 having the form of double arm levers which can roll on their axes.

The thin-walled bell 13 is rolled on and welded to the cylindrical outer surface of the bracket. The bell serves to prevent contact between the upper tips of the weights and the body of the regulator. In addition, the oil in the bell rotates together with the weights yet does not exert any lateral pressure upon them.

On the upper tip of the slide valve, ball bearing 16 is mounted, under the race of which are located the lower ends of the centrifugal weights (flyweights) and on top plate 34 is located; the latter is pressed down (held down) by conical spring 17, the upper end of which is propped against the toothed rack 5.

In this way, by raising or lowering rack 5 by means of roller 6 mounted on shaft 4, it is possible to change the tension of spring 17.

The body of the regulator is fastened to body 2 of the oil pump by means of four pins 23 (see Figure 126). The junction of the bodies is sealed with washer 24.

In order to maintain constant pressure of the oil delivered by the oil pump, a reduction valve is placed in body 2 (see Figure 125). The valve consists of guide 30 screwed into body 2 of oil pump, valve 29, valve spring 28, valve nut 31 and packing washer (ring) 32.

During the operation of the regulator, the oil presses against the face of valve 29 and, having overcome the elasticity of spring 28, displaces the valve to the right along the axis and opens the orifice of the driven gear axis of the oil pump; through this orifice the oil flows into the intake channel of the regulator.

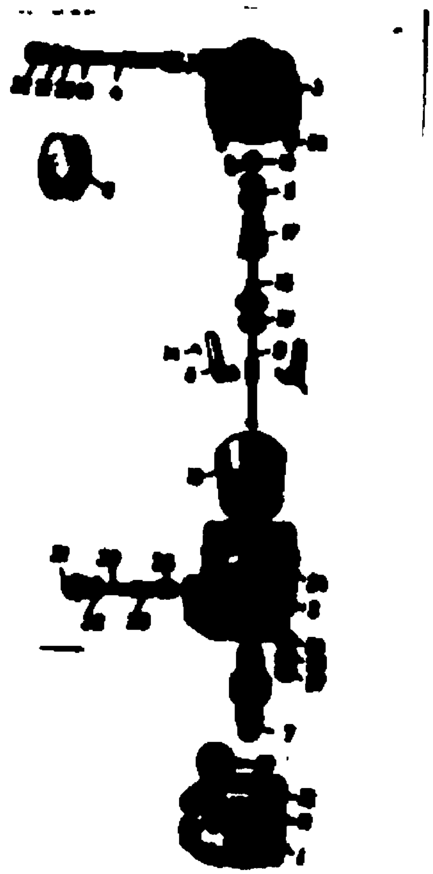

Figure 126. Components of the R-2 rpm regulator.

1 - lower body; 2 - body of oil pump; 3 - regulator body; 4 - manual control shaft; 5 - rack; 6 - roller; 7 - driving shaft; 8 - regulator weights; 9 - slide valve; 10 - driven gear; 11 - gear axis; 12 - washer; 13 - bell; 14 - weight axis; 15 - shaft; 16 - bearing; 17 - slide valve spring; 18 - nut; 19 - packing spring; 20 - ring; 21 - washer; 22 - bearing housing; 23 - pin; 24 - washer; 25 - washer; 26 - lock washer; 27 - nut; 28 - spring; 29 - reduction valve; 30 - valve guide; 31 - nut; 32 - packing ring.

The components of the regulator and their mutual arrangement are shown in Figure 126.

Mode of operation of the regulator

The M-11FK engine is provided with the V-501-D81 automatic direct action propeller. The blades on this propeller are changed into low pitch by the pressure of the oil coming from the rpm regulator, and into high pitch - by the centrifugal forces of the propeller blades.

We will now discuss the operation of the regulator during the performance of the V-501-D81 propeller.

During the rotation of the driving shaft with a number of revolutions equal to the specified ones, weights 7 and spring 8 are in equilibrium, then valve 6 assumes a center position (Figure 127a) covering (with the lower bead of the slide valve) the opening of channel 1. With the slide valve in this position, the oil in the propeller cylinder appears to be locked in and the angle of propeller blade setting remains unchanged. In the propeller cylinder such an oil pressure is created which is necessary for the equilibration of the torsional force produced by the inertia forces of the counter-weights of the blades.

If for any given reason the number of revolutions of the engine and consequently of the regulator shaft decreases, the inertia forces developed by the weights become smaller than the pressure forces of the spring 8, and slide valve 6 under the effect of the excess elasticity force of the spring 8 will drop down and connect the recess of the propeller cylinder over channel 1 with channel 5 of the oil supply from the regulator oil pump (Figure 127b). The oil will flow toward and press against the piston of the propeller mechanism. The piston will slide and through a transmission will turn the propeller blades at a smaller angle and the number of revolutions will start increasing.

This will be followed by a simultaneous increase in the number of revolutions of the regulator shaft, the centrifugal forces of the weights will overcome the tension of spring 8 and will lift the slide valve to such an extent that it will assume a neutral position (see Figure 127a).

During an increase in rpm of the engine and consequently of the regulator shaft also, the emerging excess inertia force of the regulator weights overcomes the elastic force of the spring and raises the slide valve upwards freeing the exit of the oil through channel 1 from the propeller cylinder into the recess of the engine crankcase (Figure 127b). The oil delivered by the regulator pump passes completely through the reduction valve into the main line for intake.

The propeller blades subjected to the effect of inertia forces of the propeller counter balance mass will begin rotating relative to their axis toward an increase in the angle of setting and the rpm's of the propeller will decrease. The elasticity force of the spring will overcome the inertia forces of the weights and the slide valve will drop down until it covers orifice 1. In this case the rpm will be restored back to original.

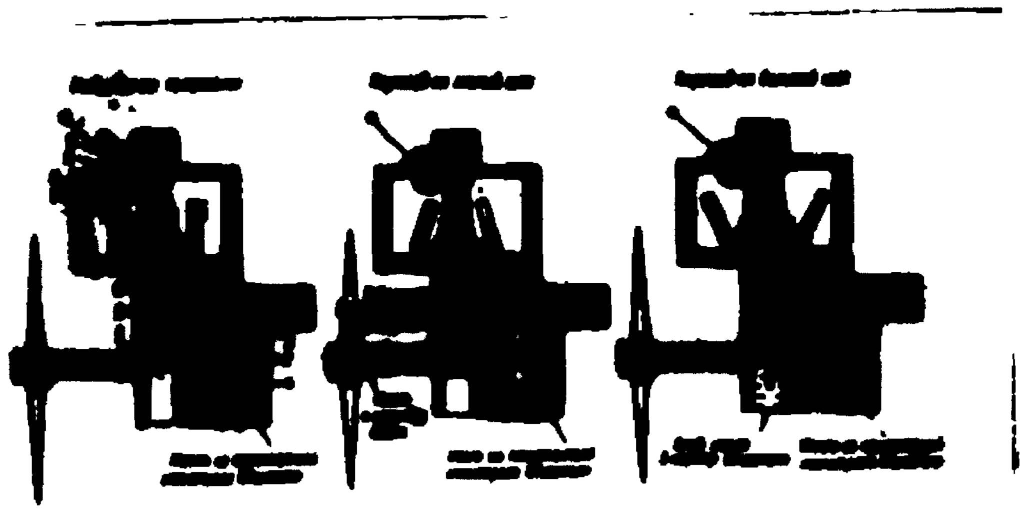

Figure 127. Principal diagram of rpm regulator operation.

a - equilibrium position (top); oil from the main line of the engine (bottom).
b - change into low pitch; increase in oil pressure to 14 kg/cm^2; oil to the propeller cylinder; oil from the main line of the engine.
c - change into high pitch; drainage of oil into engine crankshaft; oil from the main line of the engine.
1 - channel for oil delivery to propeller; 2 - oil pump gear; 3 - reduction valve; 4 - channel for delivery of oil to regulator; 5 - oil delivery channel; 6 - slide valve; 7 - regulator weights; 8 - slide valve spring; 9 - lever; 10 - rack; 11 - hand control shaft gear.

In this way, at a normal performance of the engine, the rpm's set by the pilot will remain constant.

The number of revolutions at which equilibrium approaches between spring 8 and regulator weights 7 depends upon the tension of the spring. In order to change the tension of spring 8 and consequently also the rpm of the engine during flight, the installation is also provided with hand control.

By turning the hand control wheel in the cockpit clockwise, roller 6 (see Figure 125) will also turn clockwise. Gear 11 (see Figure 127) lowers rack 10 and contracts spring 8 and the rpm of the engine increases and vice versa when the control wheel is turned counter-clockwise, the rpm decreases.

The Propeller

Designation and advantages of automatic propellers

The basic function of an aircraft propeller is the conversion of the torsional force on the engine shaft into propelling force imparting (giving) to the aircraft a forward movement with a certain speed. During the rotation the propeller traps air and drives it back to the rear thus producing a reaction force - propulsive force, which pulls the aircraft forward.

The advantages of variable pitch propellers (pitch of blades changed in flight) are that they allow total utilization of engine power during all operations, which was absolutely impossible in the case of an engine with fixed pitch propellers.

As is known, the power required by the propeller and developed by the engine varies with the change in rpm according to different laws. The power developed by the engine changes approximately proportionally to the change in rpm; but the power required by the propeller changes in proportion to the cube of the rpm.

The flying speed (airspeed) has only a slight effect. But the power required by the propeller changes considerably with the change in airspeed. If the airspeed is increased at a changed rpm then in a result, there is an increase in the speed of air approaching the blade, the angle of attack drops sharply, i.e. the propeller becomes "light" for the given engine power. In this case, in order to avoid the distortion of engine revolutions it is necessary either to throttle the engine or to increase the pitch in flight, i.e. to weight down (make heavy) the propeller, which is impossible in the case of a fixed pitch propeller.

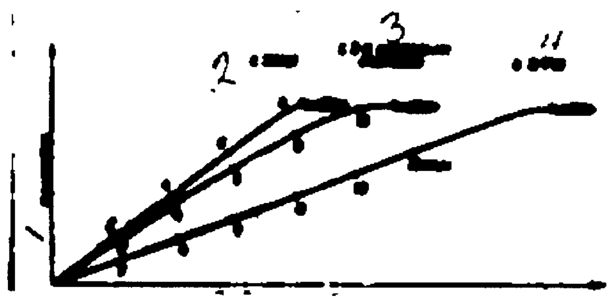

Figure 128. Take-off and climb diagram for an aircraft with fixed pitch and variable pitch propellers.

1 - altitude; 2 - with variable pitch propeller; 3 - with dual pitch propeller; 4 - with fixed pitch propeller; 5 - take-off time.

The power required for the propeller and the power developed by the engine vary with altitude also according to different laws. The power required for the propeller changes with altitude in direct proportion to air density. Consequently, as the aircraft climbs in altitude, the power required for the propeller, other conditions being equal, drops. But the power of the engine decreases somewhat faster than the power absorbed by the propeller.

Consequently, each flight condition of the aircraft requires its own propeller selected for the given concrete conditions. The propeller which would satisfy such conditions is the automatic propeller.

The automatic propeller allows one to take from the engine full power at ground level and at altitude, during climb and during horizontal flight. This is why an aircraft with such a propeller has a smaller take-off run at take-off, greater rate of climb, greater horizontal (cruising) speeds at all altitudes, except rated, and much higher ceiling as compared with the very same aircraft which does not have a variable pitch propeller.

Figure 128 shows a take-off and climb diagram for aircraft with variable pitch and fixed pitch propellers. It is evident from this diagram that the take-off and climb of an aircraft with variable pitch propeller are realised much faster.

Basic data about the propeller and its mode of operation

As already mentioned the M-11FR engine is equipped with a V-501-D51 propeller (Figure 129). The propeller is two-bladed, traction type, dextrorotatory, with automatic control by means of R-2 control unit (regulator).

Finally, the weight of the counterbalance disks is determined after the first flights of the aircraft with newly mounted propeller.

The propeller consists of the following basic units and parts: metal hub, two wooden blades, made of pine wood, covered with linen and celluloid, and parts for the attachment of the propeller to the engine. The blades have metal tippings (Figure 130).

Figure 129. General view of V-501-D81 propeller

Diameter....................................2.3 meters
Maximum blade width.........................190 mm
Weight of propeller.........................30 kg
Control data of propeller:
Minimum setting angle at radius of 700 mm......19°
Maximum setting angle at radius of 700 mm......29°
Angle of counterbalance setting:
of one blade................................13°
of second blade.............................16°
Turn bracket................................10°
Weight of counterbalance discs..............310 grams

The performance of the propeller is based on the hydrocentrifugal principle and is realized through direct connection, i.e. the propeller blades are set on small pitch by the pressure of the oil against the piston of the propeller mechanism; greater blade pitch is set by the effect of the centrifugal force moments of the counterbalance mass of the operating propeller.

Figure 130. Sectional view of propeller blade.

1 - dipping; 2 - not lower than 0.8; 3 - celluloid covering; 4 - linen; 5 - pine.

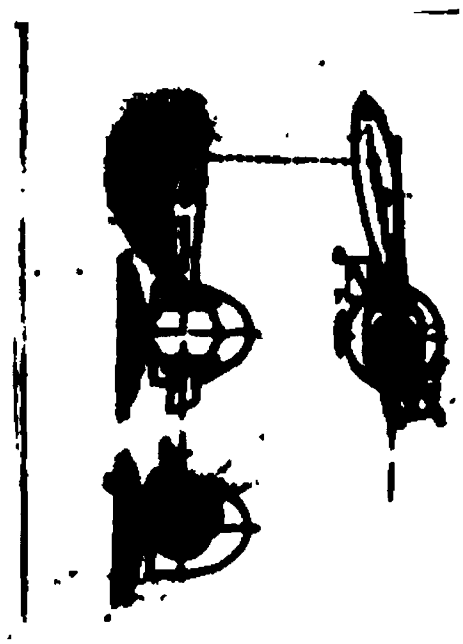

Figure 131. Diagram of the action of forces during the performance of the propeller.

N - centrifugal force of the blade;
Q - centrifugal force of the counterbalance;
T - tangential component of the centrifugal force of the counterbalance;
C - testing components of the centrifugal force of the blades;
P - thrust of the propeller and its distribution along the blades.

Figure 131 presents a diagram of the action of forces during the operation of the propeller. Each propeller blade is affected by the force of aerodynamic air resistance (drag), forming a traction force P, and centrifugal force of the blade mass N. Due to the fact that the mass of the blade is situated asymmetrically relative to the symmetry axis of the blade, it forms an additional moment of a lateral centrifugal force component of the blade C which affects the blade with a tendency of reducing the pitch. The blade counterbalances during the operation of the propeller are affected by the centrifugal force ; the component of that force (tangential component) T produces a turning moment of the blade with a tendency for increasing the pitch.

By increasing the rpm of the propeller to a certain value, the slide valve of the rpm regulator raises and opens the exit for the oil from the propeller mechanism; the propeller blade exposed to the effect of the moment of the centrifugal component force, developed by the counterbalance of the blade, turns toward the side of pitch increase, thus forcing out the oil from the propeller mechanism.

When the rpm of the propeller are reduced to a certain value, the slide valve of the rpm regulator drops and opens the access of the oil into the propeller mechanism and the blades will turn toward the side of reducing the propeller pitch; this very side is affected also by the centrifugal force moment C of the blade.

Mounting of V-501-D81 propeller on the M-11FR engine

The propeller can be delivered from the warehouse in assembled form or with blades not set in.

Upon reception of an assembled propeller, it is necessary to make a thorough inspection of same and to make certain that the propeller has no defects possibly originating during storage or transportation. The blades should have no mechanical defects, all nuts must have safety locks. After inspection, the propeller and all its components should be thoroughly wiped off conservation greases. If the propeller shaft tip is preserved, it is necessary to remove from it the conservation grease, wipe it dry and apply a thin layer of vaseline to it.

Inspect and examine the slits and threading of the propeller nose; they must be free of nicks and dents. Check whether the fastening nut screws on the propeller thread easily.

Upon receiving propeller with unscrewed (unassembled) blades, it is necessary: 1) to check according to the logbook whether the blade serial numbers correspond with the numbers of the hub; inspect thoroughly and lubricate the thread of couplings and blade adapters; the large diameter flanges on the adapters need not be lubricated - they should remain perfectly dry;

2) - to loosen the collar nut and set the blades into the shanks (the blades should be inserted into the shank of the hub according to numbers engraved on the hub and the butt end of the blade; blades can be screwed into the hub prior to mounting the propeller on the tip of the engine shaft and also after the propeller is mounted on the engine; the blades should be screwed in up to the point of resistance, blade thread - right), then loosen blades somewhat and set pointer over the zero graduation line;

3) - according to graduation line, to set counterbalance collar, fasten tightly to the edge of the adapter, and tighten the coupling bolt (tightening moment of bolt should be 6 - 10 kgm); secured after tightening;

4) - after final mounting and tightening of blade, to examine again whether the position of the graduation line is correct and whether the collar is skewing;

5) - to set counterbalance washers; the number of washers should correspond to the weight indicated in the logbook. After the propeller

has been assembled in such a manner, the latter is installed on the aircraft, for which it is necessary first:

a) to wipe thoroughly, lubricate with oil and set on the tip of the shaft with the rear cone for its support into the fastening nut of the engine shaft bearing;

b) to unscrew the blind flange (muffler) of oil system from engine shaft tip;

c) set propeller on shaft tip up to the point where it engages its rear cone by first determining the position of the wide slot. When placing propeller on shaft tip, care should be exercised not to harm the threading of the engine shaft;

d) to wipe, lubricate and place both halves of the forward cone (sleeve) on the head of the tightening nut and screw it by hand on the thread of the shaft; finally, tighten up the nut with a special wrench by means of a tap wrench with a force of 30 - 40 kg on a 1 m arm (when tightening the nuts, the propeller blades should be held by hands and at no time should a step ladder or jack be placed under the blade);

e) in place of the blind flange of the oil system, to screw spinner into shaft tip by first placing a packing washer under it;

f) to insert the spring type ring-lifter into hub, place lock spider over octahedron of nut in such a manner that its teeth will fit into the grooves of the boss; at misalignment of teeth, tighten nut. It is forbidden to unscrew the nut for the purpose of aligning the teeth of the lock spider;

g) to insert locking spring ring into boss grooves, insert spinner locking into the spring ring of the locking;

h) to mount propeller spinner;

i) to turn the propeller mounted on the engine by hand and check the flapping (play) of the blades; the blades should be set at a small pitch; the permissible flapping cannot be more than 3 mm when measuring over the control section over a radius of 700 mm (Figure 132).

Figure 132. Scheme of testing propeller knock

Testing of propeller operation on the ground

The testing of propeller operation on the ground consists in checking the rpm of the propeller at full throttle; at full throttle, the propeller should develop 1850 ± 30 rpm.

A change in the rpm is attained by changing the detachable weight of the counterbalances. By reducing the weight of the detachable weight, we increase the rpm; the rpm decreases by increasing the weight of the detachable weight.

A change in the weight of the detachable weights is accomplished by removing or adding uniform-weight washers to both counterbalances.

Minimum and maximum blade angles can be controlled by bolts which appear to be great and small pitch detainers. When controlling the rpm with the small pitch detainer, it is necessary first to check the rpm at small pitch with completely removed counterbalance washers. After the check, the washers should be replaced (check whether they correspond with the logbook date) and check operation of propeller; when making the check, compare the rpm with the number of revolutions observed during the testing of the propeller without the washers. If the rpm has decreased, it is necessary, by removing the washers one at a time, to attain such a condition that the blades should be set on the small pitch detainer and the rpm should be restored.

Remarks: the small pitch detainer control bolt is in the rear side of the hub housing and is marked by letter A in contrast to the large pitch detainer bolt which is marked with letter B, and which should not be used in this case.

The small pitch detainer bolt has a right hand thread with pitch of 1 mm. During the screwing in of the bolt in clockwise direction, the setting angle of the blade increases and decreases when bolt is unscrewed. One single revolution corresponds to a 1° change in angle. It is recommended that one turn the bolt by not more than two turns. If after two turns of the small pitch detainer bolt, the required rpm of the propeller has not been adjusted (set in), it is then necessary to change the angle of blade setting in the connecting sleeves. After the bolt has been turned, it should be reliably fastened (locked) and sealed.

Testing propeller operation in the air

The testing of the propeller operation in flight consists in the measuring of the rpm at various operational conditions of the engine.

The V-501-D81 on the Yak-18 develops the following revolutions:

During take-off......................1900 ± 30 rpm;

During climb at ground level with

open throttle......................1800 ± 50 rpm;

During acrobatics......................1900 ± 60 rpm;

During diving......................1900 ± 100 rpm.

When the rpm deviates above the permissible limit, it is recommended that the counterbalance weight be changed by following the rules described below.

If the propeller develops a higher rpm, it is necessary to increase the counterbalance weight. If the propeller shows a lower rpm, it is then necessary to reduce the counterbalance weight.

In order to exchange the counterbalance weights, it is necessary to loosen the lock nut of the counterbalance bolt and to insert or remove washers without removing the bolt. It is recommended that one insert or remove washers with a total weight of not more than 40 g. (each washer should be marked with numbers 10, 20 and 40 corresponding to its weight). After the counterbalance weights have been changed, the lock nut should be tightly closed on the bolt and secured.

All work done after the adjustment of the propeller and change of counterbalance weights should be recorded in the aircraft logbook.

It should be kept in mind that a reduction in engine power during the climb of the aircraft brings about a reduction in the torsional moment of the blades but the moment produced by the counterbalances remains practically the same because it depends not upon the flight altitude but upon the rpm of the engine. Thus there is a tightening of the propeller and the rpm decreases. This is a normal occurrence.

Test (Exam) Problems

1. What is the designation of the R-2 rpm regulator?
2. What are the basic components and units of the regulator?
3. Explain the operation of the regulator with a variable pitch propeller;
4. Explain the effects of manual control of the regulator;
5. What kind of propeller is installed on the M-11FR engine?
6. What are the advantages of an automatic propeller?
7. How do forces act during the operation of the propeller?
8. What is the order of mounting the propeller on the engine?
9. What is the permissible propeller knock and how is it tested?
10. How is the operation of the propeller tested on the ground?
11. How is the operation of the propeller tested in the air?

CHARACTERISTICS OF ENGINE OPERATION IN THE WINTER TIME

Preparation of the power unit.

The operation of an engine in the winter time requires from the maintenance personnel greater attention than is needed in the summer, because the operation becomes complicated as a result of lower atmospheric temperature. Also complicated is the preparation of the engine for starting, starting and warming up of engine, and stopping of engine.

In order not to permit excess cooling of the engine and the oil in the lubrication system in the winter, some engine parts and the aircraft lubrication system are insulated. This allows a retention of the temperature of the oil during the operation of the engine and during the readying of same for starting under normal limits.

Also insulated are the intake nozzles of cylinders extending from the air-fuel mixture collector to the intake chambers of the engine cylinders for which purpose they are covered with asbestos tape 4 - 5 mm in diameter forming one layer coated with liquid glass. This measure eliminates the possibility for overcooling the operational mixture, condensation of moisture on the walls of the pipes (vapor lock) and freezing.

In order to reduce the cooling of engine cylinders during flight, the ports in the forward disk of the cowling are covered with shutters. The air preheater is tested and adjusted. All engine control levers are tested for ease and smoothness of operation, and are lubricated with NK-30 grease.

The summer electrolyte in the batteries is replaced by winter electrolyte and an insulation cover is placed over the battery container.

Warming up of engine during starting

In the winter time, the oil poured into the tank and in all linking parts of the engine becomes solidified thus making the turning of the engine crankshaft very difficult during starting, (freezing temperature of oils used in the lubrication of aircraft engines varies between 15 - 20°). That is the reason why oil must be heated prior to starting of engine in the winter time. In order to warm up the oil in the linkages of engine parts, it is necessary to warm up the entire engine.

At an atmospheric temperature of -5° and lower, the M-11FR engine must be warmed up by an outside source of heat to a crankshaft temperature of 20 - 30°C (the temperature is controlled by the oil temperature shown on a three-pointer indicator) and up to a temperature of the cylinder heads ranging between 30 and 40°C (by the thermocouple). When being warmed up, the power unit should be thoroughly covered with a winter cover (Figure 143). The warm air from the preheaters is supplied to the engine through metal pipes through the forward blow-off ports of the lower cowling caps of cylinders No. 3 and 4. The winter cover for these ports has special cut-outs trimmed with asbestos and sheet metal. The cover openings should have valves.

All flexible hoses, rubber parts and conduits should be well protected against the stream of hot air during the preheating.

Starting and warming up of engine

At a 0° outside temperature, the mixing chamber during the starting of the engine should be filled with 2 - 4 squirts of gasoline more than in the summer, otherwise the mixture will be lean and the engine will not turn over (start).

After starting, the engine should run on low gas for a period of 5 - 6 minutes and then be warmed up at an rpm of 1200 - 1400. Special attention should be paid to the increase in oil pressure. If the oil pressure does not rise to 3 kg/cm^2 within 20 to 30 seconds, the engine should be shut-off immediately and the cause for insufficient oil pressure should be ascertained. After elimination of the defect, the engine starting is repeated.

Figure 143. Warming up of engine from outside feed sources.

At a temperature below 15°C, the engine should be warmed up at 1000 - 1200 rpm. During the operation of the engine, the temperature of the working mixture should be not lower than 20°C. When the temperature of the working mixture drops below 20°C then, for the purpose of obtaining satisfactory performance of the engine and its pickup, it is necessary to hook up the air preheater by a smooth shift of the preheater lever.

As the cylinder head temperature goes up to 90 - 100°C, the engine rpm can be raised smoothly within 3 - 5 minute intervals.

Characteristics of engine stopping

Prior to shutting down the engine, the propeller should be set at greater pitch with the aid of the rpm regulator control lever and should be run for 10 - 15 seconds at 1400 rpm. This is necessary for the purpose of removing the oil from the propeller mechanism cylinder. Immediately after the engine is shut-off, it should be covered with a winter cover.

If, after the engine has been shut off, it becomes necessary to drain the oil from it, the cowling should be removed rapidly, the oil system investigated while oil is hot, and then drain the oil from the engine. MK-22 and MS-20 oils should be drained at an outside temperature of below -5°C, and the MS-14 oil - at below -15°.

After the oil has been drained, all drainage valves should remain open.

<u>Characteristics of engine operation on diluted (thinned) oil</u>

As already mentioned, oil diluted with gasoline is used for rapid starting of engines in the winter time.

When the engine operates on gasoline diluted oil, the oil pressure in the main line drops at first but after 20 - 30 minutes of operation, it rises again because by that time the gasoline in the oil has completely evaporated.

The indications of oil pressure during the operation of the engine on diluted oil may at the beginning differ from normal indications by 0.5 - 2.0 kg/cm^2 and by 1.0 kg/cm^2 during low gas. If the oil pressure in the engine within 20 - 30 seconds after starting does not reach normal readings, it is then necessary to shut off the engine, drain the oil, charge the system (prime) with pure hot oil and then check its pressure.

The order of starting, heating and testing the engine working on diluted oil is the same as for non-diluted oil.